

1. (10%) Why are segmentation and paging sometimes combined into one scheme?
2. (10%) In the consumer-producer example program, a ring buffer queue is used to store the produced item that will be taken off by the consumer later.
 - a. In what conditions does the program need to use the lock synchronization primitive to support the correct processing?
 - b. In what conditions does the program need NOT to use the lock synchronization primitive to support the correct processing?
3. (10%) Define the difference between preemptive and nonpreemptive scheduling. Explain why strict nonpreemptive scheduling is unlikely to be used in a computer center.
4. (10%) Consider the following code segment:

```
pid_t pid;
pid = fork();
if (pid == 0) { /* child process */
fork();
thread_create( . . . );
}
fork();
thread_create( . . . );
```

 - a. How many unique processes are created?
 - b. How many unique threads are created?
5. (10%) Can a multithreaded solution using multiple user-level threads achieve better performance on a multiprocessor system than on a single processor system? Explain.
6. (14%) Consider the following page-reference string:
1, 2, 3, 4, 7, 1, 4, 5, 6, 5, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6.

Assume that there are four frames and all frames are initially empty. How many page faults would occur for the following replacement algorithms? Note that your first unique pages will all cost one fault each.

- (a) LRU replacement
- (b) FIFO replacement

7. (14%) Assume you have a system with a static priority CPU scheduler. Assume the scheduler supports preemption. Describe what the program below prints in sequence, where the priorities are set such that T2 has a high priority, T1 has the middle priority, and T0 has the low priority. Assume the system starts with only T0 executing. Assume the semaphore mutex is initialized to 1.

```
void T0 () {
    printf ( "T0-Start \n" );
    StartThread (T1);
    printf ( "T0-End \n" );
}

void T1 () {
    printf ( "T1-Start \n" );
    P (mutex);
    printf ( "T1-A \n" );
    StartThread ( T2 );
    printf ( "T1-B \n" );
    V (mutex);
    printf ( "T1-End \n" );
}

void T2 () {
    printf ( "T2-Start \n");
    P (mutex);
    printf ( "T2-A \n" );
    V (mutex);
    printf ( "T2-End \n" );
}
```

8. (12%) Suppose that a disk drive has 5000 cylinders, numbered 0 to 4999. The drive is currently serving a request at cylinder 134, and the previous request was at cylinder 125. The queue of pending requests, in FIFO order, is 86, 1470, 913, 3774, 948, 4509, 1022, 2750, 130. Starting from the current head position, what is the total distance (in cylinders) that the disk arm moves to satisfy all the pending requests, for SSTF and SCAN disk scheduling algorithms?
9. (10 %) Are the following statements about IP addresses true or false? For each statement, you will get 2 points for correct answer, zero point for blank, or -1 point for incorrect answer.
- (a) The subnet mask for the subnet 200.23.16.0/23 is 255.255.255.0.
 - (b) The subnet 200.23.16.0/23 could accommodate up to 256 hosts.
 - (c) Domain Name Service (DNS) can be used to acquire IP addresses.
 - (d) Address Resolution Protocol (ARP) can be used to acquire IP addresses.
 - (e) Network Address Translation (NAT) is used to map MAC addresses to IP addresses.